

## Assessment of Carbon Monoxide Levels in a Commercial District of Akure, Nigeria

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### Abstract

The importance of having acceptable indoor environmental quality in building interiors have been well established in rating systems like BREEAM and LEED. However, in a developing nation like Nigeria, where rating systems are under consideration and adequate provision for power is a challenge, retailers in commercial buildings tend to provide power generating sets on their own, more so the influence of vehicular traffic on indoor environment is also of concern to researchers. In the development of a green building rating system for Nigeria, models need to be developed as to the patterns of carbon monoxide (CO) levels in commercial buildings in the country. The purpose of the quantitative study is to assess the level of CO in the terraces of buildings in the Obanla district of Akure in October 2015. Eighty commercial cum residential buildings was assessed in the Ijomu, Obanla commercial axis in Akure, the capital of Ondo State, using dSense Portable CO Meter - a hand held CO monitor, on a once a week measurement, for a month. The implication of increased exposure of CO levels usually from generator fumes and vehicular traffic could lead to reduction in the oxygen carrying capacity of the blood. Results show that the average one hour measurements for eighty positions were 1.225ppm for week one, 1.775ppm for week two, 1.475ppm for week three and 4ppm for week four. These average levels are lower than the WHO indoor air requirement of 30ppm for 1 hour and the USEPA (NAAQS) 35ppm outdoor air 1 hour average.

**Keywords:** carbon monoxide levels, green building rating system and indoor environmental quality.

### 1. INTRODUCTION

World Congresses of States especially the United Nations, UN Conference on Sustainable Development, Rio+20 (UN, 2012; the Earth Summit, 2015) have raised concerns on the sustainability of the environment, such issues as depletion of renewable and non-renewable resources, pollution of air, water and land, soil degradation and high level of waste generation have been of concern to researchers (Day, 2004; Roaf, Fuentes & Thomas, 2007).

In advanced nations, the concept of green buildings and rating of buildings' have been explored as a practice that can reduce impacts of the building industry on the environment (Brophy & Lewis (2011); Atkinson, Yates & Wyatt (2009). One of the basic principles of the established Building Research Establishment Environmental Assessment Method (BREEAM) is the health and Wellbeing aspect, which aggregates up to 15% of the rating for any building (Sleeuw, 2011, p.6; Potbhare, Syal, Arif, Khalfan, & Egbu (2009, p.110). Furthermore, levels of pollutants such as carbon monoxide (CO) and particulate matter level, all contribute in one way or the other

towards rating the interiors of buildings. Other factors considered are carbon dioxide (CO<sub>2</sub>) level, light level, humidity and temperature of building interiors. Also these environmental issues have raised concern(s) on the productivity and health of users in the interior of buildings and thus have increased the health risk of users of buildings, particularly the presence of CO sometimes leading to death of occupants, specifically where power is sourced through petrol electricity generators.

In developing nations such as Nigeria and Akure South Local Government Area precisely, research into assessment of CO levels are limited, especially in relationship to buildings, hence the importance of this work.

## 2. LITERATURE REVIEW

### 2.1 Carbon Monoxide Levels and Health of Building Occupants

The purpose of the quantitative study is to assess the level of CO in the terraces of buildings in the Obanla district of Akure in October 2015 between 9am and 10am on selected days, this time was based on the previous work by Adegoke, Balogun, Odiase & Tate (2015, pg. 21), the authors observed 8am – 10am as one of the two peak periods of ambient CO concentration in Akure metropolis. Also, Farayola & Egunjobi, (2015, pg. 46) also noted that “CO concentration levels were significantly higher during the day than in the night” and concentrations of CO was observed to be higher in more densely populated areas than in the less densely populated areas. The Obanla research area is one of the down town, traditional area of Akure. The Ondo State Building and Subdivision Regulations (1984, Section 77-79) specifies that where natural ventilation is not feasible, mechanical means of ventilation can be procured for buildings to improve the health and safety of occupants. Section 80 of the regulations (Op. Cit), informs about noxious vapours, but no specifics about carbon monoxide (CO) is discussed in the regulations. The research questions raised are: What is the CO level in the terraces of buildings in Obanla – Oke Ijebu area of Akure down town? Is the air quality of these buildings in compliance with in country and international requirements?

Table 1: Comparative carbon monoxide exposure levels from different standards

S/n	Organization	Period	CO levels	Notes
1	ASHRAE	8hrs	9ppm	Standard 62.2 (2013)
2	USEPA	8hrs	9ppm	NAAQS (outdoor air)
		1hr	35ppm	NAAQS (outdoor air)
3	ACGIH	8hrs	25ppm	Threshold limit value
4	NIOSH	8hrs	35ppm	Recommended exposure limit
		15min	200ppm	Short term exposure limit
5	OSHA	8hrs	50ppm	Permanent exposure limit
6	WHO	24hrs	6ppm	Indoor air
		8hrs	9ppm	Indoor air
		1hour	30ppm	Indoor air
		15min	87ppm	Indoor air
7	NBC (2006)	1hour	200ppm	Car garages and connecting spaces
		8hrs	50ppm	Car garages and connecting spaces

Source: NBC (2006), Carbon monoxide levels and standards (n.d.)

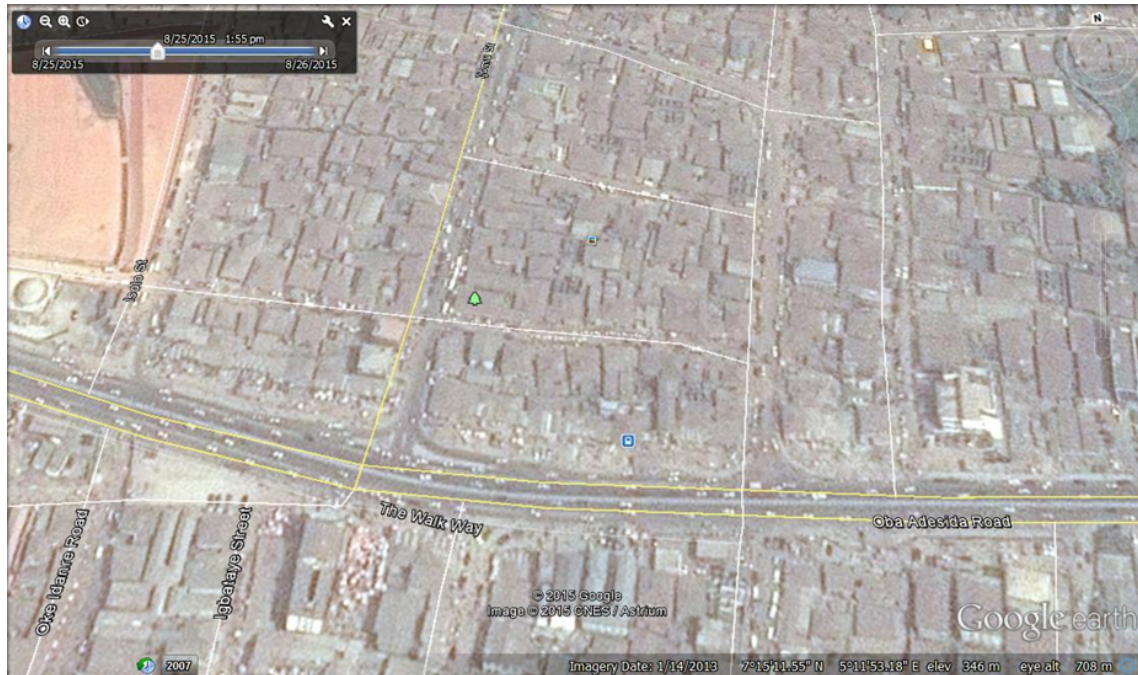


Figure 1: research area bounded by Oke Ijebu Street, Obanla Street and Oba Adesida Road, Akure ,  
Courtesy of Google Maps (2015).

Carbon monoxide is an odourless, colourless gas and it is a by-product of burning gasoline and natural gas. Common sources of CO is usually from automobiles, coal, oil and electricity generators. The site of action of CO is the haemoglobin in blood to which the carbon monoxide attaches, leading to a loss of its oxygen carrying capacity and subsequent toxic effects” (Connell, Hawker, Warne & Vowles, 2005, p.8). CO is hazardous to persons with heart or circulatory problems, or people with damaged lungs or breathing passages (ASHRAE, 92.1, pg. 29)

## 2.2 Environmental Sustainability

The Encyclopaedia of life support systems describes sustainability in terms of “protecting the planet’s life support systems to ensure longevity for humans and other species”. The term ‘development’ was further explained as “progress in social well-being or improvement in the quality of life”. While working towards this progress, it is important to take note that the ecological system is both global and finite, thus “observing nature’s limit is important in order to prevent an irreversible depletion of the life support systems” (Bell & Cheung, 2002). Sustainable development is that which “meets the needs of the present without compromising the ability of the future generations to meet their own needs” (World Commission on Environment and Development (WECD, 1987). This is by far the most widely quoted definition of sustainability.

Kwami and Adi (2012) advises that governments, professionals and educational institutions should embrace sustainability in their programmes in order to advocate for social, humanitarian and environmental factors to be paramount in their day to day responsibility towards the people. Sustainability is seen as a panacea to everyday problems such as excessive rainfall leading to flooding which displaces people, disrupting businesses and family relations, a vivid example is the flooding in Kano State, Nigeria where residents in declared risk zones were further affected due to lack of enforcement (Nabegu, 2014, p.25), whirlwind and tornadoes in the United States, excess heat on sunny days and sometimes in the night causing discomfort, the cases of urban heat island in our city centres due to activities of humans (Taha, 1997, p.101), drought in the northern part of Nigeria, erosion leading to deep gullies in the eastern part of the country and ocean encroachment in the coastal state of Lagos, Nigeria. Sustainable design considers the urban fabric, thus designers makes it a point to deliver only buildings that fit local context (Bay & Ong 2006, p.226).

### 2.3 Green Building Rating System

There is a growing awareness of the term green buildings and green building rating systems in emerging nations (Potbhare, V., Syal, M., Arif, M., Khalfan, M.M.A. & Egbu, C., 2009, pg.100). In Africa, South Africa and Egypt are countries that have existing green building councils and rating systems (GBCSA, 2016; EGGBC 2016). However, in Nigeria, the development is at best still at the discourse level within the professional bodies, for example, several conferences such as Architects Colloquium have focused majorly on sustainable development for the economy (Adabamowo & Kusimo, 2008; Prucnal-Ogunsote, Okwoli & Ude, 2011).

A green building is a building that considers and then reduces its impact on the environment and human health (Yudelson, 2009). A green building in the United States and Canada is generally considered to be one certified by the Leadership in Energy and Environmental Design (LEED), green building rating system of the U.S. Green Building Council (USGBC) or Canada Green Building Council (CaGBC). Buildings generally consume too many resources to be overlooked laments Porter (2004), thus green buildings are designed to use considerable less energy and water than a conventional building and have fewer site impacts and generally higher levels of indoor air quality. Sensible House (2013) concretizes the idea of green buildings under five sub headings: energy, materials, health, water/landscape, design.

The establishment of a Green Building Council for Nigeria can be jump started by setting up a multidisciplinary committee at the level of the Nigerian Institute of Architects, Architects Registration Council of Nigeria, and other Registration Councils of the built environment disciplines; the Town Planners Registration Council, Council for the Regulation of Engineering in Nigeria, Council for the Registration of Builders, Quantity Surveying Registration Council of Nigeria, Surveying Registration Council of Nigeria, Chartered Project Management Institute of Nigeria. This idea by Ogunsote et al (2011) suggests firstly setting up web portal managed by various disciplines in the academia, the building industry and government agencies, the web portal of the Green Building Council should be hosted by the World Green Building Council website. The Stake holders according to US Green Build 2015 Expo flier usually includes: architects, engineers, interior designers, landscape architects, builders, code officers, building owners, contractors, developers, educators/schools, facility managers, financial service providers, government agencies, green building thought leaders, utilities.

Green building rating systems are defined as “tools that examine the performance or expected performance of a whole building and translate that examination into an overall assessment that allows for comparison against other buildings” (Fauler & Rouche, 2006). The aim of any building environmental assessment system according to Adegbile (2013) is to set criteria against

which to rate a building and then to provide a score or descriptive rating for that building. This rating shows the building's environmental credentials which usually have commercial implications in terms of promoting sustainability image. Fowler and Rouch (2006) in the executive summary to the report for the General Service Administration (GSA) of the United States of America, advises that using a green building rating system allows for comparison with other GSA Buildings, other Federal Buildings and the US Building market and also as a means "to track GSA's progress towards designing and operating the best buildings for their occupants". In addition, the report assumes that "the rating systems reflect the values and priorities of the developers and countries". Maton (2013) suggested adoption of the LEED system of rating buildings in Nigeria because of the flexibility of LEED. Also Adegbile (2013) suggested the use of LEED in Nigeria, more reasons might need to be put forward towards the adoption of LEED in Nigeria, acceptance of LEED hook line and sinker may be a simplistic solution to the problem. Ultimately, sustainability will be measured based on local conditions (GRIHA, 2014). Green building rating systems promotes the use of simple techniques, passive energy principles that makes buildings more suitable for users for example; orientating the longer side of buildings in the East – West direction, the use of courtyards, atrium and cross ventilation (Brown & Dekay, 2001). Technological solutions is also encouraged; making use of alternative to grid power through photovoltaic (PV) cells, Task lighting, light control devices (Oyedepo, 2012), rainwater collection (Brophy & Lewis, 2011).

### 3. METHODOLOGY

The study made use of data collected through on site measurements as primary source, while secondary data was collected through published journals and standards. On selected days at exactly 9am. on the spot assessment using the dSense Portable CO Meter – a hand held CO monitor was used to collect data. This was recorded in a memo pad and later transferred to a Microsoft excel table which was later analysed using descriptive tools; tables and graphs.

The purpose of the quantitative study is to assess the level of CO in the terraces of buildings in the Obanla district of Akure, the terraces were selected as an initial aspect of the work and subsequent studies would be based on interiors of selected non-residential buildings. Furthermore, the terraces were selected because of the issue of access. It is easier to gain access to terraces of commercial buildings, since it is considered as a semi-public space, this is because potential customers have the liberality to pause for a moment, deciding whether there is a need to enter the shops or not.

Precautions: as advised by CO meter operation manual (n.d.)

1. Allow CO meter to run self-test in a neutral environment, free of CO, since high CO may cause failure in passing self-test
2. It is important to have backup batteries should in case low battery indicator comes up during the test
3. Keep the meter away from electronic interference, which may cause erratic reading

### 4. FINDINGS AND DISCUSSIONS

The points that are known to constitute possible higher levels of CO can be studied to detail. Such as the Car park exit point into Oke Ijebu Street from the public car park area, the motorcycle repair/ park point and the vehicular inlet area to Obanla street from Oke Ijebu Street.

Table 1: Purpose of building in the study area

S/n	Building Types	Quantity	Percentage
1	Commercial	49	61.25
2	Commercial/residential	31	38.75
Total		80	100

Two types of buildings were found in the study area: commercial buildings amounted to 61.25% (Table 1) and residential rooming buildings with the rooms closer to the streets converted to commercial purpose 38.75%. Two buildings were under construction and was not included in the project.

Table 2: Building floor levels in the study area

S/n	Building Types	Quantity	Percentage
1	Bungalows	62	77.50
2	One Storey	16	20.00
3	Two Storey	2	2.5
Total		80	100

Bungalows recorded as high as 77.50% of the buildings studied (see Table 2). One storey buildings accounted for 20% while two storey buildings were 2.5% of the lot.



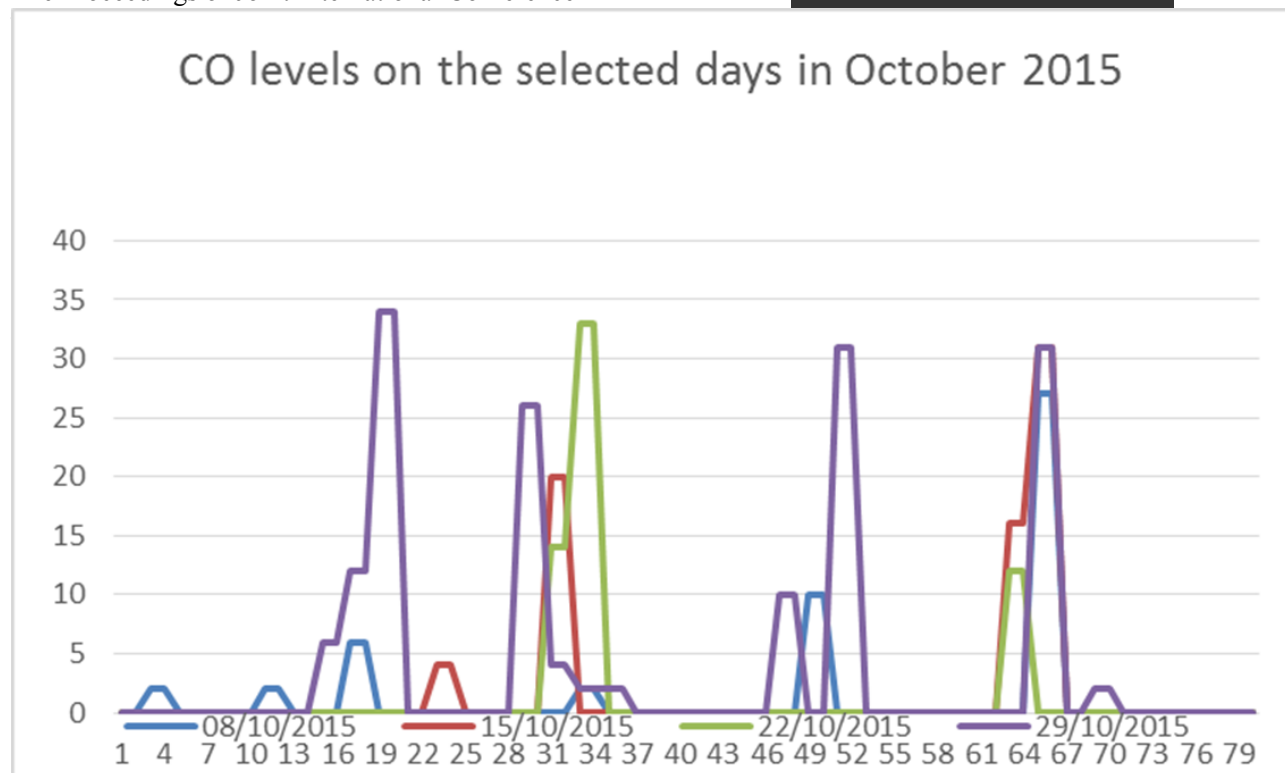


Figure 1: CO levels in station 1 to 80 on the selected days in October 2015.

Comparatively, there is considerable increase in the level of concentration between study position 13 – 20, 28 – 34, 46 – 52 and 61-67. The highest reading occurred on 29/10/2015, as high as 34ppm. The average CO concentration levels for one hour at the eighty positions were 1.225ppm for week one, 1.775ppm for week two, 1.475ppm for week three and 4ppm for week four. These average levels are lower than the WHO indoor air requirement of 30ppm for 1 hour and the USEPA (NAAQS) 35ppm outdoor air 1 hour average.

## 5. CONCLUSION

The study shows that there are certain positions that have the possibility of high CO concentration levels (as high as 34ppm) in the study area – positions 13 -20 and 46 - 52. The study further shows that comparatively, certain positions in the study area for the four weeks have consistently high CO level emissions – positions 28 – 34 and 61 - 67. On the average, it was discovered that the one hour average is lower than WHO (indoor) and NAAQS (outdoor requirements). This shows that although previous studies have indicated that vehicular traffic and generator fumes increase CO levels in the environment, the levels are still within permissible limits in the study area.

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